volume, besides rainfall statistics, contains much that is of interest to meteorologists, including some statements on the supposed connection between rainfall and sunspot frequency, that are worthy of attention.

"THE U.S. Sanitary Commission in the Valley of the Mississippi during the War of the Rebellion, 1861—1866," is the title of a very interesting volume, giving a detailed account of the organisation and working of this benevolent commission during the American civil war. It seems to have been on the whole well organised and successful in carrying out its object, thus doing much to alleviate the miseries of that unfortunate war.

MR. FREDERICK AYRTON, barrister-at-law, long resident at Cairo, who died in London recently, has bequeathed to the British Museum a splendid library of caligraphic writings in Arabic, Persian, and Turkish, collected during many years' residence in Egypt, and the market value of which probably exceeds 3,000*l.* Mr. F. Ayrton was a perfect connoisseur in the Oriental science of caligraphy, of which so little is known, artistically, in Europe; and he devoted time and money, without stint, to this his favourite study. His collection is, perhaps, unrivalled in Europe. The gift is made on condition that the trustees set apart a room in the Museum for the exhibition of these specimens of Oriental caligraphy, and that Mr. Ayrton's Arabic scribe, Asaád Effendy, be engaged for three or four years, at a salary of 100*l.* per annum, to draw up a catalogue *raisonné* of the contents of each series.

"LES Richesses Naturelles du Globe à l'Exposition Universelle de Vienne," by M. Bernardin, is the title of a short pamphlet called forth by the Vienna Exhibition, the author's object being to show that most of the industrial materials obtained from the animal, vegetable, and mineral kingdoms within the last forty years have been lighted upon by chance, and that if competent men were to make a thorough investigation of the subject, Nature might be made to contribute to industry a vastly greater amount of material than she at present does.

WE learn from Trübner's *Literary Record* that M. Alphonse Pinart has just published a catalogue containing a description of the different collections made during his stay in what was formerly Russian America (Alaska), brought to Europe, and is now exhibiting in one of the galleries of the Museum of Natural History, Paris. The collection comprises objects of Natural History in general, Palæontology, Conchology, and especially a rich collection of objects of high ethnographical interest, as costumes, tools, arms, &c., used by the aborigines of Alaska.

WE are indebted to *Iron* for the following:—During the recent building of a bridge in Holland one of the traverses, 465 feet long, was misplaced on the supports. It was an inch out of line, and the problem was how to move it. Experiment proved that the ironwork expanded a small fraction of an inch for every degree of heat it received. It was noticed that the day and night temperature differed by about 25°, and it was thought this might be made to move the bridge. In the morning the end out of place was bolted down securely, and the other end left free. In the heat of the sun the iron expanded, and towards night the free end was bolted down, and the opposite end was loosened. The contraction then dragged the whole thing the other way. For two days this experiment was repeated, till the desired place was reached. We find no record that the heat of the sun has ever been employed in this way before.

THE following is from *Ocean Highways*:—During the last three years a naval party, commanded by Lieutenant Simpson, has been employed by the Chilian Government to explore the western side of Patagonia. In November and December 1871, Lieutenant Simpson, whose narrative has only just been published, ascended the river Ayson, which falls into the sea in latitude 45° 20′ S., opposite the Chinos Archipelago, to the south of Chiloe. He soon came to rapids and waterfalls which stopped his boats, but he pressed on through the forest in pouring rain on foot, and crossed the Cordillera at a point where it has never before been visited. The country had no inhabitants, but it is well wooded, and signs of coal were found.

No. 5 of the "Lecture Extras" of the *New York Tribune*, contains seven lectures with numerous woodcut illustrations. The principal lectures are, "Sound and Hearing," "Voice and Speech," and The Explanation of Musical Harmony," by Prof. Elsberg, of the University Medical College, New York, "Deep Placer Mining in California," by Prof. Benjamin Silliman, of Yale College, and "The Seven Senses," by Dr. R. W. Raymond, U.S. Mining Commissioner.

ADDITIONS to the Brighton Aquarium during the past week:—3 Green Turtle (*Chelonia viridis*), 4 Green Lizards (*Lacerta viridis*), 45 Mackerel (*Scomber scomber*), 3 Sea-trout (*Salmo trutta*), 4 Bass (*Labrax lupus*), 8 Black Bream (*Cantharus lineatus*), 3 Shad (*Clupea Alosa*) 1 Scad (*Trachurus trachurus*) 2 Octopus (*O. vulgaris*), 2 bunches of spawn of Squid (*Loligo vulgaris*), a brood of young Lobsters (*Homarus vulgaris*), hatched in tank No. 28.

THE additions to the Zoological Society's Gardens during the past week include a Mississippi Alligator (*Alligator mississippiensis*) from New Orleans, presented by Mr. John Hanley; four blossom-headed Parrakeets (*Palæornis cyanocephala*) and an Alexandrine Parrakeet (*P. alexandri*) from India, presented by Mr. Hugh Nevill; six Zenaida Doves (*Zenaida amabilis*) from the West Indies, presented by the Right Rev. Dr. Stirling; a Tabuan Parrakeet (*Pyrrhulopsis tabuensis*) from the Feejee Islands, and a Wagler's Conure (*Conurus wagleri*) from Venezuela, both new to the collection; an Eland (*Oreas canna*) from South Africa, purchased; two Crested Porcupines (*Hystrix cristata*) born in the Gardens.

ON THE GERM THEORY OF PUTREFACTION AND OTHER FERMENTATIVE CHANGES.[*]

II.

THE author next proceeded to describe and illustrate, by diagrams enlarged from camera lucida sketches, some of the variations he had observed in organisms found in the milk glasses when introduced into other media. Another unnamed species of Oidium closely allied to that before referred to, and like it operating as a putrefactive ferment upon urine, was seen to present strange varieties according to the fluid in which it grew and the length of time it remained in it; yet, when placed in boiled milk, it returned to exactly the same character which it had when in the flask of unboiled milk in which it was first observed. But still more remarkable modifications were seen among the Bacteria. One species of very large size, but of ordinary form and movements, as seen first in the milk, presented the following, among other varieties. In Pasteur's solution it grew as motionless algoid threads with nucleated segments. In urine and turnip infusion it did not grow at all, nor did it in the albuminous fluid till boiled and cooled solution of sugar of milk had been added, when it returned to its original Bacteric form at first, but afterwards assumed the characters of a toruloid organism. In boiled milk it resumed the original Bacteric character, but, after seven weeks, the Bacteria had changed from very large to excessively minute ones.

Another species, seen in the first instance in milk, as about the most minute form of Bacterium the author had ever observed, grew in Pasteur's solution as an ordinary full-sized Bacterium; but in urine it assumed the unjointed and cork-screw shape, and the spiral movements of a Spirillum. In turnip infusion it grew with extreme rapidity as an ordinary double-rod-like moving Bacterium, but after remaining some weeks in that medium it assumed a remarkable fungoid character with greatly increased

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[*] Continued from p. 214.

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diameter, which on introduction into urine reproduced the moving Spirillum, now of very large size, and sometimes remarkably branched, but as time passed gradually growing a smaller and smaller progeny as the liquid became vitiated, till at length it lost in the urine its spiral shape, and returned to the appearance of the minute ordinary Bacterium first seen in the milk. These may serve as samples of this class of observations, which proved on the one hand how utterly fallacious are any descriptions hitherto given of Bacteria according to form, size or movement, yet, on the other hand, showing that the different Bacteria, like the different Oidia, retained amid all their variations their distinct specific characters.

The fermentative changes induced in the media by the introduction of the various organisms were next alluded to. The test-tubes of the experiment with unboiled milk were shown, and it was pointed out that each different organism was accompanied by a different appearance of the milk, implying that each was associated with a special chemical change in the fluid in which it grew. An enlarged sketch was also exhibited of the boiled milk glasses as they were seen some weeks after they had been inoculated with the various Bacteria, showing that no two of those glasses were alike. In that containing the Bacteria derived from a drop of tap-water introduced into urine the milk had changed to a beautiful green colour; that with the kind which formed the Spirillum in urine was a pure white curdy mass, sharply acid to test-paper, while a third, inoculated with a curious irregular form of Bacterium from another of the milk-flasks, was of umber brown colour. This glass was brought to the meeting because it was of especial interest, not only on account of its peculiar tint, but because it was an instance of a primary alkaline fermentation of milk. Another milk glass had been inoculated with the same organism, and had undergone the same change, assuming in a few days the same umber brown colour, accompanied by powerful alkaline reaction. This particular Bacterium was in some forms undistinguishable from pairs of granules of a form of "Granuligera," which occurred in one of the milk glasses associated with the large Bacteria above mentioned; but the Granuligera having been obtained unmixed by introducing it successively into liquids which permitted its growth, but not that of the Bacterium, it proved to be a feeble acid ferment of milk, not producing any effect upon its colour. One of the glasses sketched was of peculiar interest, because it contained a large motionless Bacterium, which had been the sole product of exposure of a glass of the boiled milk for an hour in a sitting room, the fungus spores that in all probability entered with it having been prevented from developing by the growth of the Bacterium. It happened that the Bacterium thus derived from the air refused to grow in Pasteur's solution, urine, or turnip infusion, so that if the experiment had been performed with either of those fluids, it would have afforded negative results as regards the Bacterium, though fungi would probably have appeared; and this might have been quoted as a good illustration of absence of Bacteric development after atmospheric exposure.

The Oidium, which, as before mentioned, was a powerful putrefactive ferment of urine, produced scarcely any effect on milk, which had remained unchanged in flavour for seven weeks, although converted into a thick mass, not by coagulation of the casein, but simply by the dense jungle of the fungus filaments, while test paper indicated merely a very faint increase of alkaline reaction. The fluid remaining thus unimpaired in quality, explained the luxuriant growth and healthy appearance of the fungus in it, contrasting strikingly with its characters in urine, in which it rapidly occasioned putrefaction, and then formed merely a scum of toruloid rounded cells.

In describing these facts, the author did not affect the circumlocution that would be necessary in order to avoid using the language of the germ theory. As stated at the outset, his original object in the investigation had not been to prove that theory, but to throw light upon the nature and habits of the fermenting organisms. Nevertheless, for the sake of any who might still entertain doubt upon the question, it might be well to point out that the facts which had been adduced were irreconcilable with any other view. It was plain that they utterly disproved the oxygen theory, while they indicated with sufficient distinctness that all instances of so-called spontaneous generation had been due simply to imperfect experimentation. It remained to consider shortly the only other rival theory, the somewhat specious one of chemical ferments. After pointing out some of the inconsistencies of that theory with the facts observed, and how its difficulties became increased with the discovery of every new organism with its corresponding chemical change, requiring the assumption of a new and purely hypothetical chemical ferment, the author reminded the Society that in truth there was not a fact in chemistry to favour the belief that any substance destitute of vitality possessed the one faculty which distinguished all true fermentation, viz. the property of self-propagation of the ferment. Perhaps the most remarkable instance of a chemical ferment was the resolution of the amygdalin of the bitter almond into the essential oil of bitter almonds, hydrocyanic acid, formic acid and glucose under the influence of emulsin. The amygdalin neither gained nor lost a single atom, but was simply broken up into new compounds under the influence of the peculiar albuminous principle emulsin. But did the emulsin undergo multiplication as in the true fermentations? On the contrary, it had been shown by Liebig and Wöhler in their original paper * that a certain weight of emulsin would only break up a limited quantity of amygdalin, and that the emulsin when afterwards separated no longer affected amygdalin. So far from having the property of self-propagation, it lost its catalytic power in the act of catalysis. Thus the chemical ferment theory was in truth utterly destitute of scientific basis as explaining true fermentation.

Such being the case it was contended that the germ theory must now be regarded as demonstrated; viz. that putrefaction and other true fermentations characterised by indefinite multiplication of the ferment are caused by the growth of living organisms, which, while capable of great variations according to the circumstances in which they are placed, retain their specific characters like larger plants, and like them spring only from pre-existing similar organisms.

Nevertheless the so-called chemical ferments had a high degree of interest in this question, as very likely playing an important part in bringing about the chemical changes. For just as it was proved that a peculiar albuminous principle, emulsin, existing in the sweet as well as in the bitter almond, but absent from the pea, or bean, or other leguminous plants examined by Liebig and Wöhle, could break up as much as ten times its weight of a stable crystallisable substance like amygdalin, so it seemed probable that other peculiar albuminous principles might exist in other plants, such as the fungi, and in like manner break up larger or smaller quantities of other stable organic compounds. In this sense, then, as intervening between the growth of the organisms and the resulting decompositions, the theory of chemical ferments might be welcomed as a valuable hypothesis.

Lastly, the author showed some blood obtained from a horse between three and four weeks previously, in the hope that by exposing the carotid artery antiseptically, and receiving the blood from it into a "heated" vessel, and protecting it from dust, he might, after the clot had contracted, decant off the clear serum, and inoculating or exposing the uncontaminated fluid, observe organisms and fermentations corresponding to those which occur in the practice of surgery.

But to his great surprise day after day passed without the clot showing any sign of shrinking, and it remained still uncontracted. In the flask shown, the buffy coat was seen to be present on the upper part of the still tremulous jelly-like coagulum, but instead of being powerfully pinched together into a comparatively small bulk bathed with serum, that part like the rest of the clot was everywhere in contact with the sides of the glass, and not a drop of serum was to be seen. At the same time there was no smell whatever about the cotton that covered the neck of the flask, showing that putrefaction had been avoided. Somehow or other the exclusion of living organisms, while it had not interfered with coagulation, had prevented the fibrine from acquiring a tendency to shrink. This fact, while entirely new, and opening up a wide field of inquiry, was seen to tally with phenomena met with in surgical practice, such as the absence of shrinking of the plug of clot near a ligature placed upon an artery. It was an illustration of how little we are often able to predict what may arise when even the most familiar objects are placed in new circumstances.

SCIENTIFIC SERIALS

THE *Journal of Mental Science*, July.—We have heard or read of a rather impressionable gentleman who, as he perused Dr. Buchan's "Domestic Medicine," fancied himself afflicted with

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* *See* "Annales de Chimie et de Physique," 1837, p. 185.

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